MULTIMEDIA UNIVERSITY®

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

PME0016 – MECHANICS

(Foundation in Engineering - All Sections / Groups)

6 MARCH 2017
2.30 P.M – 4.30 P.M
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **SEVEN** printed pages, including the cover page, Appendix I and Appendix II, with **FIVE** questions.

2. Answer **ALL** questions. The distribution of the marks for each question is given.

3. Write all your answers in the Answer Booklet provided.

4. All necessary workings **MUST** be shown.

QUESTION 1 (10 Marks)

a) A bungee jumper momentarily comes to rest at the bottom of the dive before he springs back upward. At that moment, is the bungee jumper in equilibrium? Explain.

[5 marks]

b) A uniform meter stick with a mass of 180 g is supported horizontally by two vertical strings, one at the 0-cm mark and the other at the 90-cm mark as in **Figure Q1(b)**. What is the tension in the string

(i) at 0 cm?

[2.5 marks]

(ii) at 90 cm?

[2.5 marks]

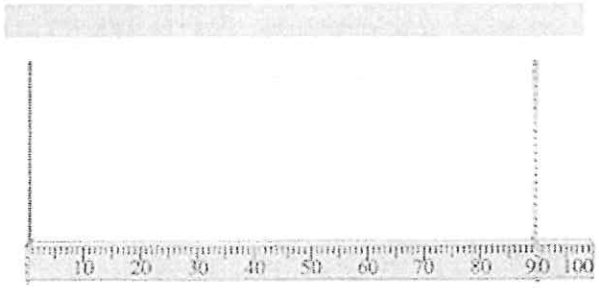

Figure Q1(b)

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QUESTION 2 (10 Marks)

a) Two water slides at a pool are shaped differently, but start at the same height h as shown in **Figure Q2(a)**. Two riders, Paul and Kathleen, start from rest at the same time on different slides.

(i) Which rider, Paul or Kathleen, is traveling faster at the bottom? Explain. [2 marks]

(ii) Which rider makes it to the bottom first? Explain. [2 marks]

Ignore friction and assume both slides have the same path length.

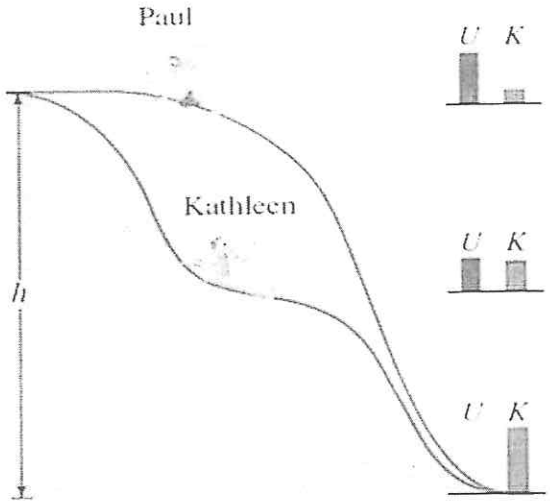

Figure Q2(a)

b) A ball of mass m = 2.60 kg, starting from rest, falls a vertical distance h = 55.0 cm before striking a vertical coiled spring, which is then compressed by an amount of Y = 15.0 cm as in **Figure Q2(b)**. By assuming the spring has negligible mass, and ignore air resistance, determine:

(i) the speed of the ball when it hits the spring [2 marks]

(ii) the spring constant [2.5 marks]

(iii) the work done by spring. [1.5 mark]

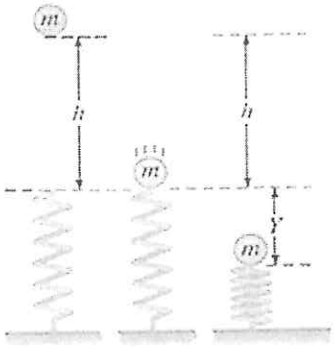

Figure Q2(b)

QUESTION 3 (10 Marks)

(a) On a rotating carousel or merry-go-round, one child sits on a horse near the outer edge and another child sits on a lion halfway out from the centre.

(i) Which child has the greater linear velocity? Explain. [2 marks]

(ii) Which child has the greater angular velocity? Explain. [2 marks]

(b) A hammer thrower accelerates the hammer (mass = 7.30 kg) from rest. After making four full turns (revolutions) and the hammer is released at a speed of 28.0 m/s. Assuming a uniform rate of increase in angular velocity and a horizontal circular path of radius 1.20 m, calculate

(i) the angular acceleration [3 marks]

(ii) the (linear) tangential acceleration [1.5 marks]

(iii) the centripetal acceleration just before release. [1.5 marks]

Continued...

QUESTION 4 (10 Marks)

A hydraulic lift is used to jack a 970-kg car 12 cm off the floor. The diameter of the output piston is 18 cm, and the input force is 250 N.

a) What is the area of the input piston?

[2.5 marks]

b) What is the work done in lifting the car 12 cm?

[1.5 marks]

c) If the input piston moves 13 cm in each stroke, how high does the car move up for each stroke?

[2.5 marks]

d) How many strokes are required to jack the car up 12 cm?

[1.5 marks]

e) Show that energy is conserved.

[2 marks]

QUESTION 5 (10 Marks)

A spring stretches 0.150 m when a 0.300 kg mass hangs from it. The same spring is then set up horizontally on a frictionless table. The mass is pushed so that the spring is compressed 0.100 m from the equilibrium point. The 0.300 kg mass is attached to the left end of the spring while the other to a wall and released from rest. Determine

(a) the spring stiffness constant k and angular velocity ω.

[3 marks]

(b) the amplitude of the horizontal oscillation A.

[1 mark]

(c) the magnitude of the maximum velocity v_{max}.

[1 mark]

(d) the magnitude of the maximum acceleration a_{max} of the mass.

[2 marks]

(e) the period T and frequency f.

[2 marks]

(f) the displacement x as a function of time.

[1 mark]

Continued...

APPENDIX I:

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 / kg^2
Universal gas constant,	R	=	8.314 J/ mol.K
Hydrogen ground state,	E_0	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_c	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity of earth,	g	=	9.80 m/s^2
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.022×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_0	=	1.0×10^{-12} W/m^2
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_0}$	=	9.0×10^9 N.m^2 /C^2
Permittivity of free space,	ε_0	=	8.85×10^{-12} C^2/N.m
Permeability of free space,	μ_0	=	$4\pi \times 10^{-7}$ T.m/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Wein's displacement constant		=	0.2898×10^{-2} m.K
Speed of Sound in Air		=	343 m/s
Refractive index of air/vacuum	n	=	1.0
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),		=	149.6×10^6 km
Earth-Moon distance (mean),		=	384×10^3 km

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APPENDIX II:

LIST OF FORMULAS IN MECHANICS

$y = kx^n$ $\frac{dy}{dx} = knx^{n-1}$	$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$	$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$	$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

$v = v_o + gt$ $\quad y - y_o = v_o t + \frac{1}{2} g t^2$ $\quad v^2 = v_o^2 + 2g(y - y_o)$

$y - y_o = \left(\frac{v_o + v}{2}\right) t$

$a_c = \frac{v^2}{r}$ $\quad F_g = G\frac{m_1 m_2}{r^2}$ $\quad U_g = -G\frac{m_1 m_2}{r}$ $\quad T^2 = K_s r^3$

$\tau = r \times F$ $\quad \sum \tau = \tau_{net} = I\alpha$ $\quad I = \sum mr^2$ $\quad v = r\omega$

$L = r \times p = I\omega$ $\quad K = \frac{1}{2} I\omega^2$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $\quad T_p = 2\pi\sqrt{\frac{l}{g}}$ $\quad T = \frac{2\pi}{\omega} = \frac{1}{f}$

$x = A\cos\omega t$ $\quad x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $\quad v = \omega A\cos\omega t$

$a = -\omega^2 A\cos\omega t$ $\quad a = -\omega^2 A\sin\omega t$

$v = \frac{\Delta x}{\Delta t}$ $\quad a = \frac{\Delta v}{\Delta t}$

$v = v_o + at$ $\quad x - x_o = v_o t + \frac{1}{2} a t^2$ $\quad v^2 = v_o^2 + 2a(x - x_o)$

$x - x_o = \left(\frac{v_o + v}{2}\right) t$

$W = mg$ $\quad \sum F = F_{net} = ma$ $\quad f_s \le \mu_S F_N$ $\quad f_k = \mu_K F_N$

$p = mv$ $\quad \sum F = \frac{\Delta p}{\Delta t}$

$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$ $\quad m_1 u_1 + m_2 u_2 = (m_1 + m_2) v$

$P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2} mv^2$ $\quad PE_s = \frac{1}{2} kx^2$ $\quad F_s = -kx$ $\quad PE_G = mgy$

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